Name: _____

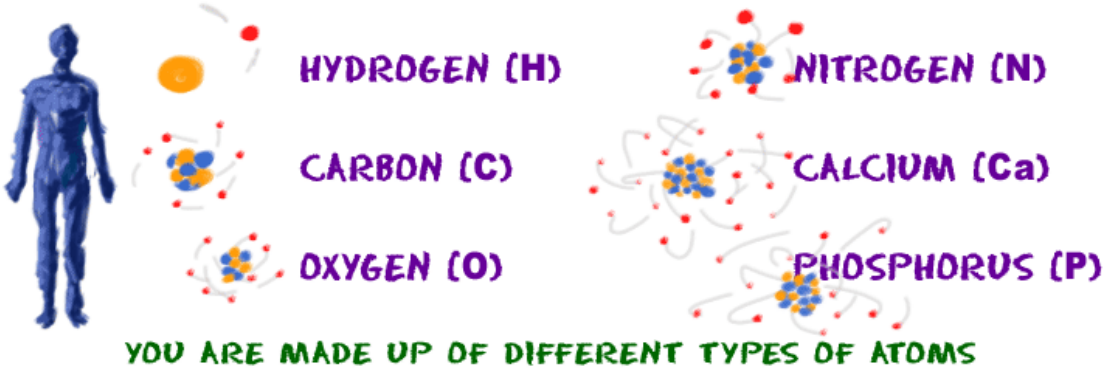
3.2 Atomic Theory
Science 9, Wolfe Spring 2020

This section has a lot of information about the parts of an atom and how they are arranged. You already looked at a single element, but in this section and the next you will look at lots of different elements and how we name and organize them. At the end of each section, I have included links to various videos that might be good to watch. All sections are essential learning.

All text with green section headings is taken from http://www.chem4kids.com/files/atom_intro.html and the related pages on the atom.

Start by watching the video "How was the atom discovered?" at https://www.youtube.com/watch?v=Cs87qH6-QTk. You won't be tested on the details! You will, however, get the big picture. You might want to watch this video again after you finish the work in this unit.

Atoms Around Us



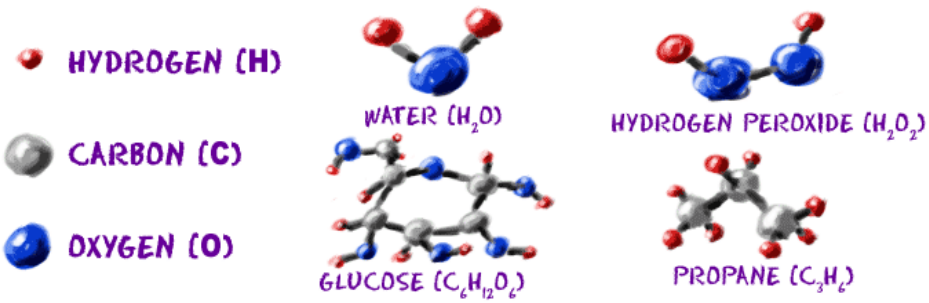
What is an atom? **Atoms** are building blocks. If you want to create a language, you'll need an alphabet. If you want to build molecules, you will need atoms from different elements. Elements are the alphabet in the language of molecules.

Each element is a little bit different from the rest. In English, you know that "B" is different from "C." In chemistry, "B" is also different from "C" because boron (B) and carbon (C) are different elements with atoms that have different structures. Atoms are defined as the smallest units of matter that have the **properties** of an individual element.

Are there pieces of matter smaller than an atom? Sure. Atoms are made up of smaller and even smaller particles of matter. However, those smaller particles don't have the properties of an element. The electrons in a gold (Au) atom are the same as the electrons in an atom of neon (Ne) – *but gold and neon are very different!*

For example, let's say you have bar of gold. Because it is pure gold, there are only gold atoms in the bar. If you only had one atom of gold in your hand, it would have the same properties as every other gold atom in that bar. But what if you only had one electron from a gold atom? That electron would not have the properties of gold anymore. It would just be an electron doing electron stuff. The atom is the smallest unit that has the properties of an element.

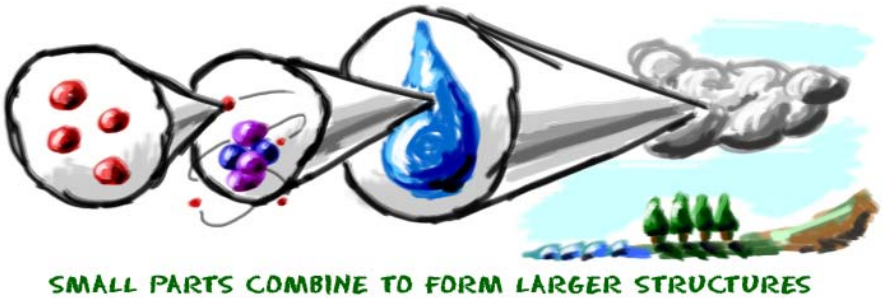
Common Elements



Let's work with the alphabet idea again. If you read a book, you will find words on each page. Letters make up those words. In English, we only have twenty-six letters, but we can make thousands of words. In chemistry, you are working with almost 120 elements. When you combine them, you can make millions of different molecules.

Molecules are groups of atoms in the same way that words are groups of letters. An "A" will always be an "A" no matter what word it is in. A sodium (Na) atom will always be a sodium atom no matter what molecule it is in. While atoms from different elements have different masses and structures, they are all built with the same parts. Electrons, protons, and neutrons are the basic subunits for all atoms across the Universe.

From Simple to Complex



Imagine the smallest particles of matter. Super-tiny subatomic particles are used to create the parts of atoms. Protons, neutrons, and electrons can then organize to form **atoms**. Atoms are then used to create the **molecules** around us. As we just learned, there are almost 120 elements that can be found in the molecules we know.

protons
neutrons
electrons
} *atoms of different elements* } *molecules*

Some good videos about this are:

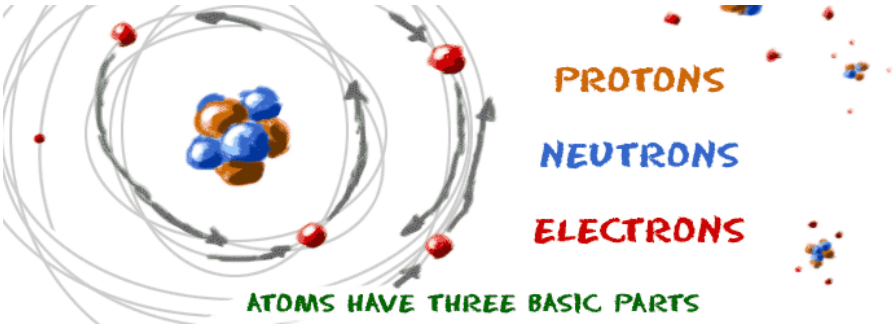
Parts of an Atom (Fuse School) https://www.youtube.com/watch?v=cpBb2bgFO6I
What are Atoms Made Of? (Stated Clearly) https://www.youtube.com/watch?v=ooWfzpUIoNM
Atoms and Elements explained: https://www.youtube.com/watch?v=q-BeFjoSuBY

And here are some cool videos related to the subject:

Using particles to "write": The World's Smallest Writing: https://youtu.be/j3QQJEHuefQ
This will blow your mind with some complicated ideas, but also explains how small atoms are: https://www.youtube.com/watch?v=_lNF3_30lUE

Atoms Are Building Blocks

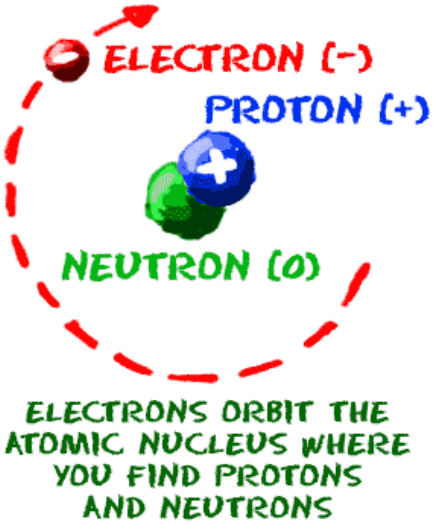
Atoms are the foundation of chemistry. They are the basis for everything in the Universe. As you know, matter is composed of atoms. Solids are made of densely packed atoms while gases have atoms that are spread out.



Are there pieces of matter that are smaller than atoms? Sure there are. Super-small particles can be found inside the pieces of atoms. However, science is based on the atom because it is the smallest distinct unit of matter.

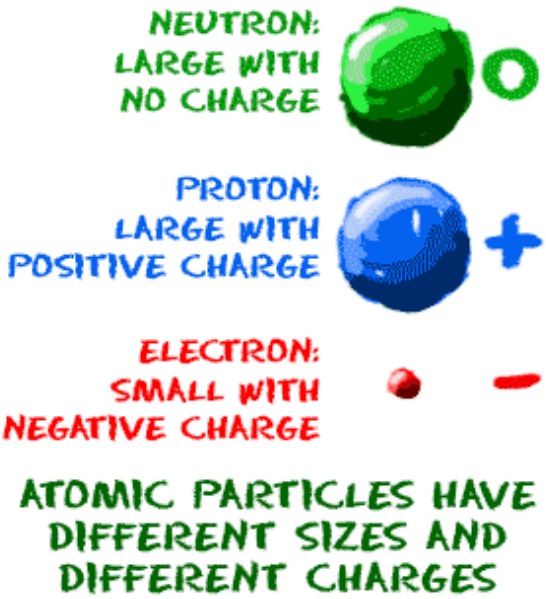
Three Easy Pieces

Even though many super-tiny atomic particles exist, you only need to remember the three basic parts of an atom: electrons, protons, and neutrons. What are electrons, protons, and neutrons? Electrons are the smallest of the three particles that make up atoms. Electrons are found in shells or orbitals that surround the nucleus of an atom. Protons and neutrons are found in the **nucleus**. They group together in the center of the atom. That's all you have to remember. Three easy pieces!



There are almost 120 known elements in the periodic table. (117 as we write this) Chemists and physicists are trying to make new ones every day in their labs. The atoms of different elements have different numbers of electrons, protons, and neutrons. Every element is unique and has an atomic number. That number tells you the number of protons in every atom of the element. The atomic number is also called the proton number.

Charges of Atoms



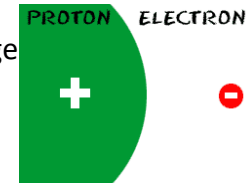
You can see that each part of the atom is labeled with a "+", "-", or a "0." Those symbols refer to the **charge** of the particle. Have you ever heard about getting a shock from a socket, static electricity, or lightning? Those are all related to electric charges. Charges are also found in tiny particles of matter.

The electron always has a "-", or negative, charge. The proton always has a "+", or positive, charge. If the charge of an entire atom is "0", or neutral, there are equal numbers of positive and negative charges. Neutral atoms have equal numbers of electrons and protons. The third particle is the neutron. It has a neutral charge, also known as a charge of zero.

Since the number of protons in an atom does not change, fewer or extra electrons can create a special atom called an ion. **Cations** have fewer electrons and have a positive charge. **Anions** have extra electrons that create a negative charge.

As you know, electrons are always moving. They spin very quickly around the nucleus of an atom. As the electrons zip around, they can move in any direction, as long as they stay in their **shell**. Any direction you can imagine — upwards, downwards, or sideways — electrons can do it. Electrons are constantly spinning in those atomic shells and those shells, or orbitals, are specific distances from the nucleus. If you are an electron in the first shell, you are always closer to the **nucleus** than the electrons in the second shell.

Charge It!



Electrons are the negatively **charged** particles of atom. Together, all of the electrons of an atom create a **negative** charge that balances the positive charge of the protons in the atomic nucleus. Electrons are extremely **small** compared to all of the other parts of the atom. The mass of an electron is almost 1,000 times smaller than the mass of a proton.

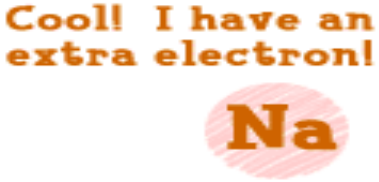
Shells

Electrons are found in **clouds** that surround the nucleus of an atom. Those clouds are specific distances away from the **nucleus** and are generally organized into shells.

Electrons are very important in the world of electronics. The very small particles can stream through wires and circuits, creating currents of **electricity**. The electrons move from negatively charged parts to positively charged ones. The negatively charged pieces of any circuit have extra electrons, while the positively charged pieces want more electrons. The electrons then jump from one area to another. When the electrons move, the current can **flow** through the system.

Looking at Ions

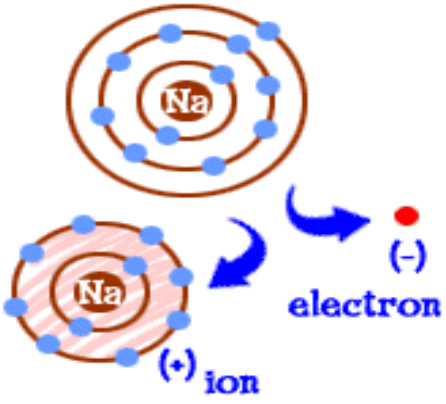
We've talked about **ions** before. Now it's time to get down to basics. The **atomic number** of an element, also called a **proton number**, tells you the number of protons or positive particles in an atom. A normal atom has a **neutral** charge with equal numbers of positive and negative particles. That means an atom with a neutral charge is one where the number of electrons is equal to the atomic number. Ions are atoms with extra electrons or missing electrons. When you are missing an electron or two, you have a positive charge. When you have an extra electron or two, you have a **negative charge**.



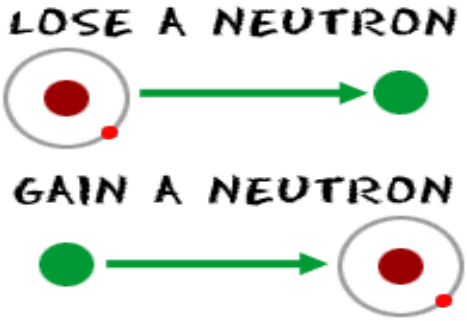
What do you do if you are a sodium (Na) atom? You have eleven electrons — one too many to have an entire shell filled. You need to find another element that will take that electron away from you. When you lose that electron, you will you'll have full shells. Whenever an atom has full shells, we say it is "happy." Let's look at chlorine (Cl). Chlorine has seventeen electrons and only needs one more to fill its third shell and be "happy." Chlorine will take your extra sodium electron and leave you with 10 electrons inside of two filled shells. You are now a happy atom too. You are also an ion and missing one electron. That missing electron gives you a positive charge. You are still the element sodium, but you are now a sodium ion (Na^+). You have one less electron than your atomic number.

Electrovalence

Don't get worried about the big word. **Electrovalence** is just another word for something that has given up or taken electrons and become an ion.



Neither Here nor There



Neutrons are the particles in an atom that have a **neutral charge**. They aren't positive like protons. They aren't negative like electrons. But don't start thinking that they aren't important. Every piece of an atom has huge importance to the way the atom acts and behaves. Neutrons are no exception.

So, if an atom has equal numbers of electrons and protons, the charges cancel each other out and the atom has a neutral charge. You could add a thousand neutrons into the mix and the charge would not change. However, if you add a thousand neutrons, you will be creating one super-radioactive atom. Neutrons play a major role in the mass and **radioactive** properties of atoms. You may have read the page on isotopes. Isotopes are created when you change the normal number of neutrons in an atom.

The **atomic mass** is the number of protons and neutrons together in an atom. Two atoms of the same element can have different atomic mass if they are different isotopes – they have the same number of protons, but one has more neutrons so it weighs more.

One Special Element

Did we say that all atoms have neutrons? Oops. All elements have atoms with neutrons except for one. A normal hydrogen (H) atom does not have any neutrons in its tiny nucleus. That tiny little atom (the tiniest of all) has only one electron and one proton. You can take away the electron and make an ion, but you can't take away any neutrons.

Watch the video:

Atomic number & mass number (FuseSchool)
https://www.youtube.com/watch?v=_S7ov25y3_M

And some more videos for interest and fun:

13 Most Fascinating Elements Explained: https://www.youtube.com/watch?v=qbaJCpigpFE
Seeing the smallest thing in the universe: https://www.youtube.com/watch?v=6IeeshkVATY

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3.2 Notes
Science 9 – Wolfe, Spring 2020

Main ideas – fill in the blanks:

Atoms are the building blocks of matter, and atoms of different _____ can be arranged into _____. An atom is the smallest particle that displays the _____ of an element.

Atoms consist of three particles: the proton, which has a charge of _____, and the neutron, which has a charge of _____, both live in the _____ of the atom. Electrons, with a charge of _____, surround the nucleus.

Atoms are usually neutrally charged, but if they gain or lose electrons, they become charged particles called ions. If they lose electrons, their charge becomes _____ and they are called _____. If they gain electrons, their charge becomes _____ and they are called _____.

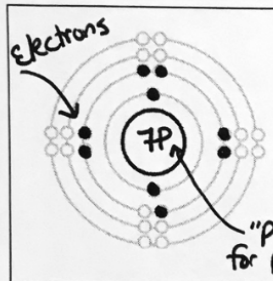
Electrons live in clouds around the nucleus that are specific distances from it and organized into _____.

The atomic number of an element is the number of _____. The atomic mass is the number of _____ and _____. The smallest particles, _____, have almost no mass and so they don't count in the atomic mass. If atoms of the same element have different number of neutrons, we call them different _____ of the element.

Name: _____

3.2 Worksheet

Complete the atoms with the number of protons, number of electrons, and the charge



# of protons 7 (+7)

# of electrons 9 (-9)

charge = -2 (+7 - 9)

Charge

# of protons _____

# of electrons _____

charge = _____

# of protons _____

# of electrons _____

charge = _____

# of protons _____

# of electrons _____

charge = _____

# of protons _____

# of electrons _____

charge = _____

# of protons _____

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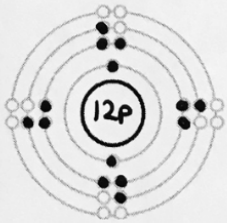
charge = _____

# of protons _____

# of electrons _____

charge = _____



# of protons _____

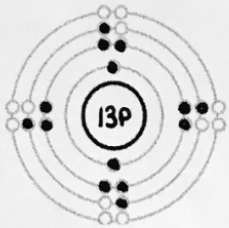
# of electrons _____

charge = _____

# of protons _____

# of electrons _____

charge = _____

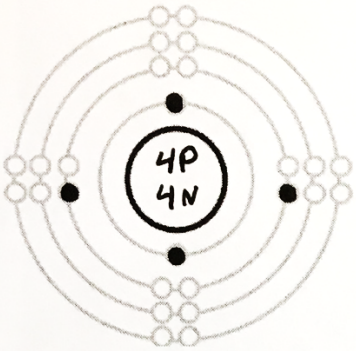


# of protons _____

# of electrons _____

charge = _____

Complete the atoms with the number of subatomic particles, atomic mass, and atomic number.



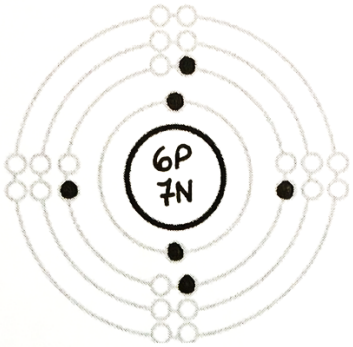
# of protons _____

# of neurons _____

# of electrons _____

Atomic number: _____

Atomic mass: _____



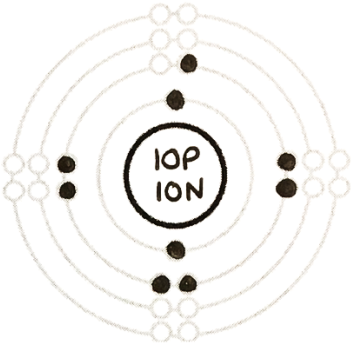
# of protons _____

# of neurons _____

# of electrons _____

Atomic number: _____

Atomic mass: _____



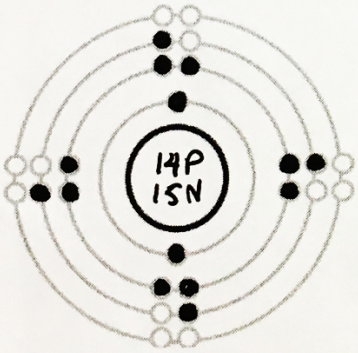
# of protons _____

# of neurons _____

# of electrons _____

Atomic number: _____

Atomic mass: _____



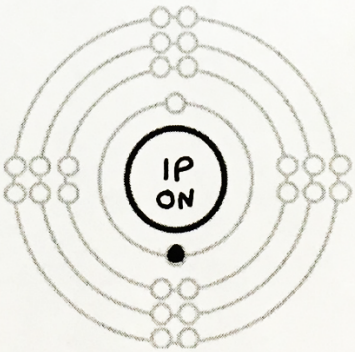
# of protons _____

# of neurons _____

# of electrons _____

Atomic number: _____

Atomic mass: _____



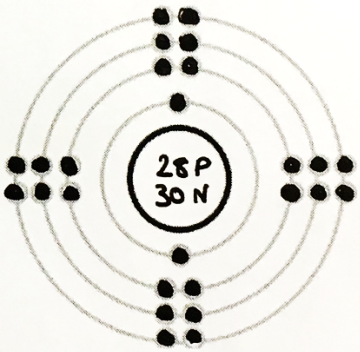
# of protons _____

# of neurons _____

# of electrons _____

Atomic number: _____

Atomic mass: _____



# of protons _____

# of neurons _____

# of electrons _____

Atomic number: _____

Atomic mass: _____